ELECTROCHEMICAL PREFERENTIAL OXIDATION OF CARBON MONOXIDE FROM REFORMATE

Examiner: Z. Best S.N. 10/566,405 Art Unit: 1795 June 17, 2008

Election/Restrictions

1. Applicant's election without traverse of Claims 1-20 in the reply filed on May 23, 2008 is acknowledged. Claims 21-49 are withdrawn from further consideration as being drawn to a nonelected group.

Specification

2. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. Examiner suggests mention of a "fuel cell" or "electrochemical cell" using the reformate stream.

Claim Objections

3. Claim 7 is objected to because it is an improper format for a Markush group. *See* MPEP 2173.05(h). Appropriate correction is required.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-20 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites the limitation "the anode" and "the cathode" in paragraphs (a), (d), and (B). Claims 11-13 also recite said limitation. There is insufficient antecedent basis for this limitation in the claim. Claim 1 further recites "a resin cavity type," which is indefinite as it extends the scope of the expression. *See* MPEP 2173.05(b).

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claims 1-12, 14-15, and 17-18 are rejected under 35 U.S.C. 102(b) as being anticipated by Maeda et al. (US 6,329,092 B1).

Regarding Claim 1, Maeda et al. teach an electrochemical device comprising a first electrochemical reactor (13) comprising multiple electrochemical cells (col. 4, line 67 – line 5, line 1), each of the cells including an anode (3, anode compartment) having gas channels (7, gas inlets and outlets), a cathode (2, cathode compartment) having gas channels (6, gas inlets and outlets), and an ion-conducting electrolyte membrane between the anode and cathode (1, ion selective partition), the gas channels (7) in fluid communication with the anode of each of the cells (fig. 1), the gas channels (6) in fluid communication with the cathode of

each of the cells (fig. 1), and a load in electrical communication with the anode and cathode of the cells that is controlled (13a, galvanostat), a gas source in fluid communication with the anode and cathode of the cells (col. 5, lines 54-67) including at least two components that are selectively reactive relative to each other (col. 6, lines 6-32), the selectivity being dependent upon an electrical potential between the anode and cathode (col. 6, lines 1-27), whereby a constant current between the anode and cathode causes the electric potential to oscillate autonomously while the gas components are directed through said anode and cathode, the oscillation in potential causing autonomous oscillation of selective reaction of the gas components (col. 6, lines 1-27), and a fuel cell system (12) that includes a stack of fuel cells, each of the fuel cells having an anode (3, anode compartment), a cathode (2, cathode compartment), and an electrolyte membrane between the anode and cathode (1, proton-exchange membrane), wherein the gas channels of the electrochemical reactor are in fluid communication with the fuel cell system (col. 6, lines 1-27 and fig. 2).

Regarding Claim 2, Maeda et al. teach the gas source is in fluid communication with the anodes of each of the cells (col. 4, line 64 - col. 5, line 9).

Regarding Claim 3, Maeda et al. teach a gas outlet of the electrochemical device is in fluid communication with the anode of the fuel cell system (col. 5, lines 61-67).

Regarding Claim 4-5, Maeda et al. teach the gas source comprises carbon monoxide of 1000 ppm (col. 6, lines 1-27).

Regarding Claims 6 and 9, Maeda et al. teach the fuel cell is a polymer electrolyte membrane fuel cell (col. 1, lines 6-9, proton-exchange membrane fuel cell).

Regarding Claim 7 and 10, Maeda et al. teach the membrane (1) is a polymer electrolyte membrane (col. 1, lines 19-22, proton exchange membrane).

Regarding Claim 8, Maeda et al. teach the gas source is a CO-containing, hydrogen-rich reformate source (col. 1, lines 35-40 and fig. 6).

Regarding Claims 11-12, Maeda et al. teach the anode and cathode are gas diffusion electrodes with a catalyst including Pt and/or Ru (col. 4, lines 51-63).

Regarding Claim 14, Maeda et al. teach the polymer electrolyte membrane (proton exchange membrane) is a solid polymer (col. 4, lines 51-63).

Regarding Claim 15, Maeda et al. teach the solid polymer is a perfluorinated ionomer (col. 1, lines 51-63).

Regarding Claim 17, Maeda et al. teach the load (13a, galvanostat) is set to a value of 500 mA/cm^2.

Regarding Claim 18, Maeda et al. teach a carbon monoxide analyzer in fluid communication with an outlet of the electrochemical reactor (51).

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al., as applied to Claims 1-12, 14-15, and 17-18.

Regarding Claims 19-20, Maeda et al. teach the electrochemical device as recited in Paragraph 7. However, Maeda et al. do not specifically teach what happens to the power output of the reactor.

Maeda et al. does specifically note that the oxidation reaction in the reactor produces power output (col. 6, line 27). It would have been obvious to one having ordinary skill in the art at the time the invention was made to integrate the power output of the reactor with the power output of the fuel cell system because the purpose of the electrochemical cell is to provide power to a power consuming device. Furthermore, fuel cells for use in electric automobiles (such as the one taught by Maeda et al., see col. 1, lines 6-9), are typically run in conjunction with a rechargeable battery (also contained in the automobile), and therefore, it would have been obvious to provide the reactor power to a rechargeable battery because the rechargeable battery requires power, which it would normally get from the power output of the fuel cell.

10. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al., as applied to Claims 1-12, 14-15, and 17-18, and further in view of Hiroshima et al. (US 6,911,278 B2).

Regarding Claim 13, Maeda et al. teach the electrochemical device as recited in Paragraph 7. However, Maeda et al. do not teach said catalysts further include at least one

element selected from the group consisting of carbon black, aluminum oxide, manganese oxide, cobalt oxide, nickel oxide, silver oxide, and a mixture thereof.

Hiroshima et al. teach a catalyst for a fuel cell, particularly a solid polymer-type fuel cell (col. 1, lines 11-24, proton exchange membrane), wherein manganese oxide, cobalt oxide, or nickel oxide are added to the platinum base (col. 4, lines 12-28). It is advantageous to add said oxides to the catalyst because they will improve catalytic activities (col. 4, lines 12-28). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to create the electrochemical device of Maeda et al., wherein said catalysts further comprise either manganese oxide, cobalt oxide, or nickel oxide because Hiroshima et al. teach that the addition of said oxides to a platinum catalyst base will improve catalytic activities.

11. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Maeda et al., as applied to Claims 1-12, 14-15, and 17-18, and further in view of Cavalca et al. (US 2001/0033960 A1).

Regarding Claim 16, Maeda et al. teach the electrochemical device as recited in Paragraph 7. However, Maeda et al. fail to teach said solid polymer is reinforced with polytetrafluoroethylene (PTFE).

Cavalca et al. teach an ionically conductive membrane for use in a fuel cell (par. 129), wherein said membrane is a perfluorinated ionomer reinforced with PTFE (par. 130). It is advantageous to use the reinforcing PTFE because the membrane will have good strength,

high ionic conductance, and good interfacial contact with the electrode (anode or cathode) (par. 129). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to create the electrochemical cell of Maeda et al., wherein the solid polymer is a perfluorinated ionomer reinforced with PTFE because Cavalca et al. teach said membrane will have good strength, high ionic conductanct, and good interfacial contact with the electrode.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Zachary Best whose telephone number is (571) 270-3963. The examiner can normally be reached on Monday to Thursday, 7:30 - 5:00 (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dah-Wei Yuan can be reached on (571) 272-1295. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Zpb

/Dah-Wei D. Yuan/
Supervisory Patent Examiner, Art Unit 1795